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Outcome of bipolar vs unipolar hemiarthroplasty in elderly: A systematic review

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Abstract

Background: Preference between bipolar hemiarthroplasty (BH) and unipolar hemiarthroplasty (UH) for displaced femoral neck fractures in elderly remains controversial. A systematic review was conducted to evaluate the differences in the outcome between BH and UH and arrive at a conclusion.

Methods: A systematic literature search (up to April, 2019) was conducted by accessing Cochrane and PubMed data base to include RCTs comparing BH with UH for displaced femoral neck fractures. Authors independently analysed and extracted data. Complications and outcomes were recorded and analyzed.

Results: A total of 9 RCTs consisting of 1248 patients were identified. At short term follow up (4 to 6 months), BH had better functional outcome with respect to hip function but in long term (after 1 year) results were similar in both groups. At short term follow up, complication like dislocation and reoperation were more in BH group where as in the long term acetabular erosion rate was higher in UH group. Other complications such as infection and mortality rates were similar in both groups.

Conclusions: Based on the current evidence, BH is superior to UH with respect to acetabular erosion but UH is superior to BH with respect to dislocations and reoperation. Though follow up showed higher acetabular erosion rate in UH group, it did not affect Harris Hip score at final outcome (80.45% in bipolar and 78.52% in unipolar). UH is cost effective when compared to BH.

Keywords: Femoral neck fractures, arthroplasty, hemiarthroplasty, randomized controlled trials, systematic review

Introduction

Femoral neck fractures are one of the most common injuries in the elderly [3]. Its treatment remains as one of the challenges even today. The treatment for fracture neck of femur is chosen depending on several factors. Increased life expectancy has led to increase in the incidence of hip fractures with a high morbidity and mortality in elderly [5]. This increase in incidence can be attributed to gradual decline in physical activity contributing to the bone loss. Though this fracture is seen in elderly as a result of trivial trauma, in young more severe trauma is necessary to produce a fracture neck of femur. Thus, it is natural to conclude that more than one mechanism operates to cause a fracture neck of femur.

Austin Moore introduced vitallium prosthesis in 1940 to replace proximal femur and then changed to a straight stemmed prosthesis in 1950. Thomson introduced prosthesis for replacement hemiarthroplasty in 1950, initially non cemented and later changed to cemented version [10]. Since then over a period of 70 years, hemiarthroplasty using Moore's and Thomson's prosthesis has remained as a standard procedure for replacing the head and neck of femur in elderly. It enables the patient to bear weight early and return to activities of daily living. Subsequently during last 30 years the design changed to bipolar prosthesis in an attempt to improve [11]. Fixing these fractures subjects a patient to limited activity and exposes him to complications of AVN, resorption of neck and non-union [4]. The factors considered before replacement hemiarthroplasty are age of the patient, type of the fracture, duration of the fracture and quality of the bone.

The decision to perform hemiarthroplasty using a unipolar or bipolar prosthesis remains debatable, with proponents on either side [4]. The unipolar prosthesis is a single unit where in movement occurs between acetabulum and prosthesis.

On the other hand in a Bipolar prosthesis, a small head articulates with polyethylene cup and large metallic head attached to outer side of the cup articulates with acetabulum. At a given time movement takes place in one of the two articulations there by distributing the stress during activities of daily living. This property is supposed to limit the wear of the component as well as wear in the region of acetabulum [1, 2, 3].

Many randomized controlled trials (RCTs) have evaluated the benefits of BH & UH, but there is inconsistency across the studies regarding outcomes. This inconsistency in RCT's observed with respect to rate of dislocation, infection, mortality and evaluation by Harris Hip score (HHS) formed the basis of this systematic review.

2. Materials and Methods

2.1 Eligibility criteria

Articles published in the English-language literature were identified which met the following eligibility criteria: (1) patients sixty years of age or older with a displaced femoral neck fracture, (2) the intervention was either bipolar or unipolar hemiarthroplasty (3) the outcome measures were Harris Hip score and rate of acetabular erosion.

2.2 Identification of studies

A search was conducted through Medline articles published from 1996 to 2019, identifying the population (hip fracture or femoral neck fracture), the intervention (hemiarthroplasty), and the methodology (clinical trial). We used the keywords "femoral neck fracture" and "arthroplasty." We utilized the

clinical search engine PubMed and Cochrane library. Authors reviewed the titles and, if the title suggested any possibility that the article might meet eligibility criteria, they retrieved and reviewed the abstracts. They then chose potentially eligible studies for retrieval.

2.3 Data abstraction

All relevant information with respect to the population, intervention and outcomes were abstracted from each selected article. Articles were evaluated giving importance to whether the authors of the study reported important characteristics associated with outcomes of hip fracture management, such as age, gender and follow up period. Data was also abstracted with respect to rate of dislocation, wound infection, acetabular erosion and mortality.

2.4 Data analysis

Out 9 RCTs comparing Bipolar with Unipolar hemiarthroplasty for femoral neck fractures were included in the present study, 3 were from India, 2 from America, one from United Kingdom, two from Singapore and from Taiwan. People of all races were included. Sample size in the RCTs ranged from 48 to 270. A total of 1121 patients involving 566 for BH and 555 for UH were identified. Mean age group in BH and UH is 77.3 and 77.6 years respectively. Table 1 summarizes the characteristics of the study.

Data was collected in Excel sheet. SPSS version 23 is used for data analysis. Independent sample t-test is used for those variables which are normally distributed. Mann-Whitney U test is used for variables which are not normally distributed.

Table 1: Study characteristics of the included studies

	Author	country	Study design	Total patients	BH	UH	Mean age		Gender		Mean follow up
							BH	UH	F	M	
1	S.J. Calder	UK	RCT	250	118	132	82	82	215	35	22 M
2	Carl	SWE	RCT	120	60	60	85	87	91	29	12 M
3	Frank j	USA	RCT	115	55	60	82	81	83	32	12 M
4	Vishwanath	INDIA	RCT	102	52	50	70	69	62	40	12 M
5	Sai Krishna	INDIA	RCT	96	52	44	70	69	56	40	12 M
6	Anand	INDIA	RCT	120	90	30	73	73	NA	NA	24 M
7	Charles	USA	RCT	48	33	15	77	77	36	12	6 M
8	Dennis	SGP	RCT	270	106	164	72	74	233	37	48 M
9	Christian	SWE	RCT	120	60	60	85	87	91	29	48 M

3. Results

3.1 Mortality rate

5 out of 9 articles have reported the mortality rate out of which 4 studies have shown no significant difference in mortality rate between both groups [mean 14.43% (43/298) in bipolar group and 14.66% (33/225) in unipolar group, p value is 0.420] with mean follow up period of 15 months [3, 6, 7, 9]. The study by Carl *et al.* reported mortality reported 22% (13/60) in bipolar and 12% (7/60) in unipolar group at the end of 1 year follow up with mean rate of 17% [2]. (table 2)

Table 2: The study reported mortality reported

Mortality rate	BH	UH
Carl <i>et al.</i>	13/60	7/60
Frank <i>et al.</i>	12/55	12/60
Anand <i>et al.</i>	3/90	0/30
Charles <i>et al.</i>	2/33	1/15
Christian <i>et al.</i>	13/60	13/60
	43/298(14.43%)	33/225(14.66%)

3.2 Erosion rate

6 out of 9 studies reported acetabular erosion rates, total 13/467 (2.78%) in bipolar group and 29/332 (8.73%) in unipolar group [1, 4, 5, 6, 8]. Carl *et al.* and Anand *et al.* reported significantly higher rates of acetabular erosion in unipolar group 20% and 23% respectively, where as in bipolar group 5% and 11% respectively [2]. (table 3)

Table 3: Reported significantly higher rates of acetabular erosion in unipolar

Erosion rate	BH	UH
Calder <i>et al.</i>	0/118	3/132
Carl <i>et al.</i>	2/44	10/49
Vishwanath <i>et al.</i>	0/52	2/50
Sai Krishna <i>et al.</i>	0/52	4/44
Anand <i>et al.</i>	11/90	7/30
Dennis <i>et al.</i>	0/106	3/164
	13/467 (2.78%)	29/332(8.73%)

3.3 Dislocation rate

4 out of 9 RCTs have reported about the dislocation rates, total 12/347(3.45%) patients in bipolar and 4/222(1.8%) in unipolar group [1, 6, 7, 8]. There was no significant difference in both groups. The study of Anand Kaushal *et al.* reported significant higher rate of dislocation in bipolar group [11% (10 /90 cases)], Out of them 7 treated with closed reduction and rest of them treated with open reduction [6]. (table 4)

Table 4: Show the significant higher rate of dislocation

Dislocation rate	BH	UH
Calder <i>et al.</i>	1/118	2/132
Anand <i>et al.</i>	10/90	0/30
Charles <i>et al.</i>	1/33	1/15
Dennis <i>et al.</i>	0/106	1/164
	12/347 (3.45%)	4/222 (1.8%)

3.4 Infection rates

5 out 9 studies have reported infection rates, over all infection rate was 4.3% (18/418) in bipolar group and 3.3% (14/420) in unipolar group [4, 5, 6, 7, 8]. None of the studies shown any significant difference in rate of infection in both groups. (Table 5)

Table 5: None of the studies shown any significant difference in rate of infection in both groups

Infection rate	BH	UH
Charles <i>et al.</i>	4/118	5/132
Anand <i>et al.</i>	3/90	0/30
Dennis <i>et al.</i>	2/106	3/164
Vishwanath <i>et al.</i>	3/52	2/50
Sai Krishna <i>et al.</i>	6/52	4/44
	18/418(4.3%)	14/420(3.3%)

3.5 Harris hip score

7 out of 9 studies have measured the functional outcome based on Harris Hip score [1, 2, 4, 5, 6, 8, 9]. Mean Harris Hip score was 80.45% in bipolar group and 78.52% in unipolar group. Both groups showed good functional outcome and there was no significant difference in both groups, but Frank *et al.* reported patients with bipolar prostheses did better on walk tests and had better range of motion at 6 months, Carl *et al.* and Christian *et al.* reported better HHS at 4 month follow up but there was no significant difference in HHS in final follow up [3, 2]. (table 6)

Table 6: Difference in HHS in final

Harris Hip score	BH	UH
Calder <i>et al.</i>	72	70
Carl <i>et al.</i>	77.7	78.2
Vishwanath <i>et al.</i>	90	84
Sai Krishna <i>et al.</i>	90.03	84.4
Anand <i>et al.</i>	78.4	76.8
Dennis <i>et al.</i>	79.3	78.7
Christian <i>et al.</i>	75.8	77.6
	80.45	78.52

By using normality test we got infection rate to be normally distributed and mortality, erosion, dislocation rate are not normally distributed. P value of <0.005 is considered as statistically significant. (Table 7)

Table 7: The variable of Mann-Whitney u test and confidence interval

Variable	t-test	Mann-Whitney U test	p-value	95% confidence interval
Mortality rate	---	8.500	0.420	---
Erosion rate	---	6.500	0.065	---
Dislocation rate	---	7.500	0.886	---
Infection rate	0.730	---	0.486	-1.726 to 3.326
Harris hip score	0.612	---	0.552	-5.044 to 8.987

4. Discussion

UH is the favored technique for the treatment of displaced femoral neck fracture in elderly patients, due to its low blood loss, relatively short operative time, extremely low dislocation rate and good long-term results at follow-up. The other technique is BH.

This systematic analysis of two groups with mean age (77.6 in UH and 77.3 years in BH, table 1) showed no significant difference in infection, mortality and dislocation rate between the two groups (p value 0.486, 0.420 and 0.886 respectively). Infection rate was 4.3% and 3.3%; mortality rate was 14.33% and 14.66%; dislocation rate was 3.4% and 1.8% in BH and UH group respectively. There was much lower incidence of acetabular erosion in bipolar group compared to unipolar group [13/467 (2.78%) in bipolar and 29/332 (8.83%)] but the difference was not statistically significant (p value is 0.065). Though acetabular erosion rate is higher in UH, it did not alter the functional outcome as measured by Harris Hip score. In principle, BH should provide better range of movements and less wear because of its design but analysis does not support the claim both during long term and short term follow up (Harris Hip Score in BH and UH was 80.45 and 78.52 respectively and the p value is 0.552).

Infection, dislocation and erosion rates have great impact on quality of life. Hospital cost mounts with these complications and may cause higher rate of mortality and Moridity. The problem of acetabular erosion may have limited impact on the clinical outcome in elderly patients whose life expectancy is shorter.

Swedish Hip Arthroplasty Register between 2005 and 2010 which included 11177 unipolar and 12323 bipolar hemiarthroplasty showed that bipolar implants have a higher risk of reoperation irrespective of cause (dislocation, infection or periprosthetic fracture) when compared to unipolar implants. In this large-scale study, they recommended unipolar implants, especially for elder patients [14].

Zhiping Zhou *et al.* published as meta analysis comparing unipolar versus bipolar hemiarthroplasty in 2014 and concluded that both unipolar and bipolar HA have satisfying results for displaced femoral neck fractures and the theoretical advantages of bipolar HA have not been supported by clinical studies [16]. Therefore, considering the cost factor, unipolar hemiarthroplasty is a more cost-effective treatment for the displaced femoral neck fractures in elderly when compared to bipolar hemiarthroplasty.

Though most of the BH in the study were cemented none of the articles have mentioned complications arising out of bone cement and cementing techniques. Also, the articles have not mentioned particulars of those excluded cases for reasons of loss of follow up.

5. Conclusion

This systematic review concludes that results of both bipolar and unipolar hemiarthroplasty in elderly are equally satisfying in the long run, though rate of acetabular erosion was more in unipolar group. However, rate of dislocation were more in BH necessitating secondary procedures for correction. Also, the cost incurred is more in BH group which is worth noting. The systematic analysis concludes both procedures are not superior to one another and unipolar hemiarthroplasty has an equal status to Bipolar Hemiarthroplasty and to be considered as an acceptable treatment in elderly patients with poor life expectancy.

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